eRD23 *Streaming readout for EIC detectors* **Summary**

Accomplishments to date

Working together with colleagues engaged in the YR progress, we could establish that a streaming readout paradigm is not only feasible, but the preferred model for an EIC.

The eRD23 project's main objective was to bring together the different groups working on modern readout solutions. This was highly successful, with two workshops per year, attended not only by JLAB and BNL personnel, but also by representatives of smaller labs, commercial enterprises, and receiving inputs from Collaborations (LHCb, ATLAS and ALICE at CERN, CBM and PANDA at FAIR, MESA at MAINZ) actively working on new streaming RO solutions. It is important to note that a large fraction of attendees are not working on EIC and related experiments, but on projects already making use of streaming readout, or at least in later stages of planning, facilitating the transfer of knowledge and underlining the general trend towards streaming readout in the community. In the workshops, we identified commonalities and differences between different approaches, and began to lay the groundwork for design decisions. The community now has a concrete plan for the overall approach, including risk mitigation at initial bring-up. We also prepared data rate estimates and discussed the timing system.

Because of the limited funding, most practical developments were performed as part of other projects, e.g. sPHENIX at BNL, CLAS12 at JLab or funded through other EIC R&D Consortia (e.g. eRD1).

Assessment of technological readiness

The general feasibility of streaming readout is evident by current HEP experiments making use of, in many cases, extreme forms of streaming readout. In contrast, the requirements of EIC, especially with regard to online event reconstruction and suppression of raw data, will be much more relaxed. Initial estimates of data rates suggest smaller to-disk rates than other experiments scheduled to run before EIC (e.g. sPHENIX), and network bandwidth is no bottleneck. However, these estimates are based on a certain selection of detector technologies, estimates for noise rates and channel counts. While existing ASICs and front end solutions cover a broad range of requirements, the overall detector concepts are still too fluent to design a readout system (triggered or streaming). It is therefore possible that the final choice of detector will require a new, green-field design of an ASIC. It will be critical to identify such a case as soon as possible. We want to note that typically, SR-capable designs are simpler, and easier to port from technology node to node, than those supporting a hardware trigger.

The total data amount (independent of readout paradigm) will be substantial, and modern data management, analysis preservation, online monitoring and associated tooling needs to be developed. However, we have not identified fundamental hurdles to do so.

Assessment of work remaining for a TDR

For the TDR, the remaining design work has to be performed in lockstep with the detector design, as only then suitable front end electronics solutions can be identified, and data rate estimates can be performed. If current rate estimates hold, the complete raw rate can be written to disk. We do not expect design issues with regard to bandwidth or similar for the transport network, even for substantially higher rates than currently anticipated. However, I/O bandwidth will then be a bottleneck, and we would need to design online data reduction steps, with plausible reduction estimates and feasibility studies for the TDR.